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ABSTRACT

The under-representation of women and African Americans in engineering spurred the research documented in this study. This document reports the reults of a study investigating middle school (in a southeastern rural community) children's attitudes toward persistence, life goals and sex-stereotypes, as potential barriers to their pursuit of engineering careers. It was designed to validate previous research on southeastern college freshmen that found no difference between persistence and life goals but large gender differences on sex-stereotyped barriers against women in engineering by men. Race, gender, and race-by-gender effects were studied on 88 middle schoolers between the ages of 13 to 15 (25 black males, 15 white, 25 black females, 23 white). Results indicate that males have higher scores on persistence than females, and black males have higher scores than white males. Multivariate analysis of variance (MANOVA) indicates that race and the sex-by-race interaction effect were not significant at the .05 level of significance. The main effect for gender of sex-stereotypes was significant beyond the .01 level. T-test results indicate that freshmen males harbor more sex-stereotyped opinions against women in engineering than eighth grade males. (Contains 27 references.) (PR)

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RACE AND GENDER EFFECTS ON PERSISTENCE, BARRIERS TO ENGINEERING AND LIFE GOALS BY MIDDLE SCHOOL CHILDREN

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ABSTRACT

This study investigated middle school children's attitudes toward persistence, life goals and sex-stereotypes, as potential barriers to their pursuit of engineering careers. It was designed to validated previous research on southeastern college freshmen which found no differences between persistence and life goals but large gender differences on sex-stereotyped barriers against women in engineering by men. Freshmen race effects were unaddressed because race minorities were unavailable.

The current study focused on southeastern rural community middle school clientele, typical of prospective freshmen at the college where the previous research was compiled. Minorities in the middle school were more appropriately proportioned to the southeastern population. Thus, race, gender and race-by-gender effects were studied on 88 middle schoolers between the ages 13 to 15 (25 black males, 15 white; 25 black females, 23 white) in the 8th grade. The freshmen study survey instrument was investigated for reliability and modified for middle school sample.

MANOVA tested the null hypothesis of no significant race, gender, and interaction effects on life goals, persistence and sex-stereotypes. The gender effect on sex-stereotypes was significant ($F=5.10$, $df=3,82$, $p=.003$) at the .05 tested level. This replicated the freshmen study findings.

BACKGROUND

The under-representation of women and American blacks in engineering spurred the research documented in this study. The social barriers to an engineering career for minorities have been criticized since the 1960's in terms of civil rights; however, just removing institutional barriers has not truly opened doors for the vast majority of minorities (Garelick, 1980; Williams, 1990). Something else needs to be done to channel the great national wealth of intelligence in the minorities into careers of engineering.

Declining enrollments in engineering, math and sciences is an alarming national threat. The 1987 Freshmen Survey Report quotes sharp declines in engineering of more than a fourth since 1982. In 1982 only 8.5 percent of the entering freshmen expressed interest in engineering careers. This percentage was down from 9.7 in 1986 and well below 12.0 percent in 1982 (American Council on Education, 1987).

A review of the literature revealed that barriers to successful completion of an engineering degree may include background variables, financial concerns, career awareness and maturity, sex stereotyped views that few women manage a career in engineering, or are able to master the math necessary for the degree, personality factors of locus of control, persistence, responsibility, self esteem, self-doubt and others, and finally, abilities in math and science (Ware, Steckler & Leserman, 1985; Swanson & Hansen, 1985; Eccles, 1986; Ivey, 1988; Metz & Campbell, 1987).

One reason for declining minority enrollment in non-traditional careers has been attributed to the lack of encouragement to study math and science and

failure to make students aware of the relationship of these subjects to professional careers (Daniels, 1987). The critical period for developing affect for these subjects are the middle school years. Research on similar populations of elementary and middle schoolers generally show gender differences in self-selected occupations splitting the selections into traditional and nontraditional, with girls being more androgynous and choosing more non-traditional roles for themselves than males who choose more traditional roles for themselves (George & Schaer, 1983; George & Schaer, 1985; George & Schaer, 1988). On the other hand, a study on a Lousiana sample of 5th and 8th graders found no significant differences by gender on generalized opinions toward traditional male and traditional female and sex-neutral occupations, but found males and females chose traditional roles for themselves (Shaw & Gorrell, 1985). Although children change their career aspirations many times during elementary training, early level mentoring and involving students in exciting experiments which they control are two methods to encourage children to study math and science. Investiagations into affect for math and science show males have higher math and science preferences than females (Illfelder, 1980; Lauderdale & Schaer, 1985). Another reason is the lack of understanding by these students of the influences of their own locus of control, persistence values and other psychological factors, the expectation for success in relation to the amount of effort expended, the potential costs of investing (Eccles, 1986; Green, et al, 1982). Peer pressure based on sex and race stereotyped opinions can also greatly handicap women and blacks in making good career decisions (Adams, 1988; Daniels, 1988; Landis, 1988; Hazell, 1987; Baird, 1981; Iker, 1980).

American blacks and women have additional barriers which limit encouragement into engineering and the sciences. Preconceived ideas on the part of elementary, middle school teachers, and parents create additional barriers when they fail to encourage blacks and females to excel in math and science at an early age or else encourage those who do not have the abilities needed to succeed in engineering (Turner, Johnson & Patterson, 1981). The socio-economic status of American blacks also dictates the expectations of a child's future career goals. Although women and blacks who have been accepted into engineering are of the same academic quality as white males, they are not always expected to achieve at the same level (Humphreys, 1988). In addition, there are few junior high programs which have engineering based technology courses which can prepare blacks and females for engineering curricula. Another problem is the lack of role models for young students in non-traditional careers (Green, et al, 1982; Turner, et al, 1981).

The purpose of this study was to determine whether gender or race differences exist on perceptions of life goals, persistence and sex-stereotypes by middle school student attitudes as compared to college freshmen attitudes.

METHODS AND PROCEDURES

Instrument Development

The instrument used in this study was designed to determine attitudes of freshmen entering the engineering program of a southeastern university (Schaer, B. B.; Aull, J.; Pancake, C. & Curtis, C. 1990 (a); Schaer, B. B.; Aull, J.; Pancake, C.; Curtis, C. and Wiens, G. 1990 (b)). The original front page of the instrument was not used for middle schoolers because the

background information and personal interests were not appropriate for middle school children. In addition to the 10 items on sex-stereotyped barriers for women and 16 finance, locus of control, and career awareness (Schaer, et al, 1990 a), 20 items on career attitudes and finance were added along with 24 items from a Persistence Marker Scale (Dermen, French, Harman, 1978). Not all of the items were used because total reliabilities indicated that students were not internally consistent in their responses. Therefore only the ten items measuring sex-stereotyped views were used to form a barrier total score, as used in the freshmen study. The persistence scale measured persevering, determinedness, and persistence; quitting, fickle, needing change, getting discouraged (reversed); and play before work (reversed). All 24 were combined to form a total persistence score after reversing the items. Each of the scales used in the freshmen study was studied for internal consistency using coefficient alpha.

Subjects

Eighty-eight students from the 8th-grade classes in a small city school system (285 students in all) were the subjects of this research. Forty percent of the students in this school are lower economic income families and received free lunches. In the total school, 21% are enrolled in advanced classes for English or math or both, and 11% will go on to college. The school has 14 full time and 4 part time teachersand would classifiy as a rural school.

Of the eighth graders, 11% are in an advanced class for English, or math. Subjects in this sample consisted of 88 students (25 black males, 15 white males; 25 black females, 23 white females).

Procedure

The data gathered on the 4 classes 8th graders was the culmination of career day activities at the school year end. Counselors went into classrooms to talk to students about career aspirations, options and how to prepare for those options. In addition to talks from teachers and counselors, mentors and 11 role models were available on career day to talk to students. Two weeks after career day, the questionnaire was given as a follow up activity to 8th grade classes.

Dependent and Independent Variables

In order to validate the previous study on college freshmen, the original research plan was to use the same dependent measures used on the freshmen studies (Schaer, et al, 1990 a & 1990 b) which were: career awareness, sex barriers, finance, locus of control, academic comfort, life goals and persistence. However internal consistencies for some of the measures were not high enough to ensure reliable dependent measures, and were dropped from this study. The three dependent measures chosen were: sex barriers, life goals and persistence. The independent variables in this study were sex and race.

Hypothesis

The first null hypothesis tested was: there will be no significant main effects for race and sex or their interaction effect on the dependent variables, sex barriers, life goals and persistence.

The second null hypothesis tested was: there will be no significant difference between male freshmen and male 8th graders; and female freshmen and female 8th graders on the significant dependent measures.

ANALYSIS AND RESULTS

Of particular interest in this study were the differences between gender and race (independent variables) and persistence, life goals and sex-stereotypes (dependent variables). Internal consistency coefficient alpha for the total persistence score was .65 on this sample of 97 eighth graders. Coefficient alphas for 97 eight graders on ten sex-stereotyped attitudes was .53 and on the 8 life goals was .63. Because of missing data, the following analysis was conducted on 88 subjects.

Another source of variation was the interaction between gender and race. Multivariate analysis variance was used in to address the null hypothesis: there is no significant difference of race and gender and their interaction on the persistence, life goals and sex-stereotyped total scores. The persistence total score was of special interest. The higher the score the more persistence a person is likely to have. In this study, males scored both highest and lowest with black males reporting significantly more persistence than white males. The ordinal interaction caused by a reverse in the female scores by race washed out the main effect for gender on persistence.

Multivariate analysis of variance was used to test the null hypothesis of no significant race, gender, and interactions effects on means and standard deviations of life goals, persistence and sex-stereotypes. Means and standard deviations on the dependent measures for each group are reported in Table 1. The MANOVA test for race and the sex by race interaction effect was not significant at the tested .05 level of significance (Table 2). The main effect for gender on sex-stereotypes was significant beyond the .01 level ($F=5.10$, $df=3,82$, $p=.003$). The first null hypothesis was rejected, and the

findings replicated the freshmen study (Schaer, et al, 1990 a; b) but did not support findings by Shaw and Gorrell (1984) on a similar sample from Louisiana, where students tended to be more open minded for others but conservative for themselves. On explanation for the difference between the Louisiana and current study is that the current study used 10 items stated stated in general and in specific for the respondent. The Shaw and Gorrell study investigated the two aspects of stereotyping in separate items.

Table 3 reports the summary statistics for the MANOVA and the following univariate analysis of variance tests.

The means and standard deviations for 8th graders were compared to the freshmen means and standard deviations. A t-test for significance of difference between two means for independent samples was used to evaluate the differences between male freshmen and male 8th graders, and again for female freshmen females and female 8th graders. The null hypothesis for each of these independent tests was: there will be no significant difference between means and standard deviations on sex-stereotyped barriers (composed of 10 items) by freshmen males and 8th grade males; and by freshmen females and 8th grade females.

The results of the independent t-test for males was significant ($t = 2.76$). The null hypothesis was rejected. Freshmen had a significantly higher mean of 29.0, sd =4.7 than 8th grade males whose mean was 26.53, sd = 5.4. In other words freshmen males harbor more sex-stereotyped opinions against women in engineering than 8th grade males.

On the other hand, the independent t-test for females was not significant ($t = 1.04$) and the null hypothesis was not rejected.

Eight grade females had a mean of 22.59, sd= 4.95 and the freshmen females had a mean of 27.1, sd=4.5.

IMPLICATIONS

These data are descriptive of the young males and females of two prominent races, black and white, in a southeastern rural junior high school setting. Attitudes and opinions are the basis of discrimination, which prevent these students from aspiring to careers in engineering. Counselors and teachers need to be aware of these attitudes if any advancement is to be made in equalizing the proportion of blacks and whites, males and females in upper socio-economic professions which contributes to the nation's wealth. The lack of significance in the persistence and life goals variables for black and white males and females is useful information when defining attrition rates over all engineering schools which nationally report more females than males drop out even though grade point averages are higher for females (Garelick, 1980). The findings that junior high males have significantly higher means than junior high females and significantly lower means than freshmen male means (i.e, freshmen have more sex-stereotyped views) indicates that the development process for young males needs to be more closely observed. Is there a debasing influence on young males in childrens' literature, sports, entertainment, televison programs or is this phenomena a harmonal imbalance? Findings from this study prompt these researchers to question, what happens in high school to solidify non-rational predudices against women in these professions?

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TABLE 1

MEANS AND STANDARD DEVIATIONS OF BLACK MALES, WHITE MALES
BLACK FEMALES AND WHITE FEMALES ON TOTAL PERSISTENCE,
LIFE GOALS AND SEX BARRIERS
(N = 88)

	MALES						FEMALES						TOTAL	
	BLACK			WHITE			BLACK			WHITE				
	MEANS	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD	N	MEAN	SD
PERSISTENCE	13.56	3.53	25	14.47	3.98	15	13.48	2.97	25	13.48	3.96	23	13.67	3.54
LIFE GOALS	31.80	4.57	25	33.80	4.56	15	34.32	3.72	25	33.35	3.83	23	33.26	4.20
SEX-STEREOTYPE	28.20	5.66	25	24.87	5.15	15	23.04	6.18	25	22.13	3.72	23	24.58	5.76

TABLE 2

MULTIVARIATE AND UNIVARIATE TESTS OF SIGNIFICANCE FOR RACE

GENDER AND RACE BY GENDER INTERACTION ON PERSISTENCE,

LIFE GOALS AND SEX STEREOTYPE BARRIERS

(N = 88)

	MULTIVARIATE					UNIVARIATE				
Source of Variation	Wilk's Value	App. F	Hyp. DF	Error DF	Sig. of F	Hyp. MS	Error MS	DF	F	Sig. of F
RACE	.956	1.27	3	82	.292					
Persistence						4.31	12.83	1,84	.34	.564
Life Goals						5.56	17.23	1,84	.32	.572
Sex Stereotype						94.68	28.11	1,84	3.37	.070
SEX	.843	5.10	3	82	.003					
Persistence						6.00	12.83	1,84	.47	.496
Life Goals						22.49	17.23	1,84	1.31	.256
Sex Stereotype						327.91	28.11	1,84	11.66	.001*
SEX BY RACE	.952	1.37	3	82	.259					
Persistence						4.34	12.83	1,84	.34	.562
Life Goals						46.46	17.23	1,84	2.70	.104
Sex Stereotype						30.90	28.11	1,84	1.10	.297

* Significant at .05 Tested Level